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Removal of hexavalent chromium from aqueous solution by granular and powdered Peganum Harmala

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ABSTRACT

In this paper, batch removal of hexavalent chromium from aqueous solutions by granular and powdered seeds of Peganum Harmala was investigated. The Peganum Harmala seeds were collected and after beating slowly, separating and cleaning the Harmala seeds done using a sieve. Batch adsorption studies were performed in 100 ml Erlenmeyer flasks inside an incubator container. The main process parameters considered were pH, initial Cr(VI) concentration for PPH and GPH, adsorbent dose, and contact time. Cr(VI) was measured at a wavelength of 540 nm using a UV–vis T80+ spectrophotometer. The adsorption data were fitted well by Freundlich isotherm. The result shows that the maximum removal of Cr(VI) was observed at pH 1.5 for both adsorbents. Also, by increase adsorption dose, adsorption capacity of Cr(VI) decreased but the chromium adsorption rate increased. The mount of adsorbed Cr(VI) onto both adsorbents increased with an increase in the contact time but by increases initial concentration of Cr(VI), the mount of adsorbed Cr(VI) onto both adsorbents decreased. The results indicate that the powdered Peganum Harmala can be effective adsorbent than the granular Peganum Harmala for the removal of Cr(VI) from aqueous solution.

1. Introduction

The discharge of heavy metals into aquatic ecosystems has become a matter of concern over the last few decades [1]. Among the different heavy metals, hexavalent chromium (Cr(VI)) is a common and very toxic pollutant [2], which based to the maximum concentration limit for Cr(VI) for discharge into inland surface waters is 0.1 mg/l and in potable water is 0.05 mg/l [3]. Cr(VI) can by variety of industries such as electroplating, leather tanning, metal finishing, nuclear power plant, textile industries, and chromate preparation discharged into the environment [4,5]. In the environment chromium occurs mainly in the oxidation states (III) and (VI) whereas Cr(III) is essential in human nutrition (especially in glucose metabolism) as well as for plants and animals at trace concentrations [3–6]. Acute exposure to Cr(VI) causes nausea, diarrhea, liver and kidney damage, dermatitis, internal hemorrhaging, and respiratory problems. Inhalation may cause acute toxicity, irritation and ulceration of the nasal septum and respiratory sensitization (asthma) and may also increase cancer risk. Also skin contact with chromium may cause allergy, dermatitis, skin necrosis and skin corrosion [7,8].

It is therefore essential to remove Cr(VI) from wastewater before disposal into the environment. In wastewater treatment, various methods applied to remove chromium include chemical precipitation, ion exchange, electrochemical precipitation, reduction, adsorption, Solvent extractions, membrane separation, concentration, evaporation, reverse osmosis and biosorption [9]. The conventional process used for removal of Cr(VI) from wastewater is reduction and its precipitation as chromium(III) hydroxide. But this procedure is not completely satisfactory and has several disadvantages like generation of a large amount of secondary waste products due to various reagents used in a series of treatments such as reduction of Cr(VI), neutralization of acid solution and precipitation. The various researches have shown that the adsorption process can be a substantial method for the removal of chromium species from aqueous solutions. For these purpose, a variety of natural and synthetic materials have been tested as chromium adsorbents [10]. The various adsorbents tested in past include activated carbon and char [11,12], the modified clay [13], rice husk ash, activated alumina, coal fly ash [14] and modified corn stalk [15], etc. Therefore, there is a need for the development of low cost, easily available materials that could allow to remove and recover Cr(VI) economically [10]

Regarding the difference in adsorption capacity of various adsorbents as well as cheapness, variety and ease of access, the use of regional adsorbents is studied to evaluate their applicability. *Peganum Harmala* is a self grown and common plant that grown mainly in Throughout Iran especially the surrounding area of

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